ENERGY STAR® Program Requirements
Product Specification for Computer Servers

Draft Test Method
Rev. May-2012

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1 **Note**: This Test Method revision is reformatted for clarity and incorporates updates to support the active
2 mode testing criteria in the specification. As this topic remains under development, the Test Method will
3 be further revised prior to finalization of Version 2.0 to address updates from the draft development
4 process.

5 # 1 OVERVIEW

6 The following test method shall be used for determining compliance with requirements in the ENERGY
7 STAR Product Specification for Computer Servers, and when acquiring test data for reporting of Full Load
8 power on the ENERGY STAR Power and Performance Data Sheet.

9 # 2 APPLICABILITY

10 The following test method is applicable to all products eligible for qualification under the ENERGY
11 STAR Product Specification for Computer Servers.

12 # 3 DEFINITIONS

13 Unless otherwise specified, all terms used in this document are consistent with the definitions contained
14 in the ENERGY STAR Product Specification for Computer Servers.

15 # 4 ACRONYMS

16 A) Ac: Alternating Current

17 B) BIOS: Basic Input Output System

18 C) Dc: Direct Current

19 D) DOE: U.S Department of Energy

20 E) EEE: Energy Efficient Ethernet

21 F) EPA: Environmental Protection Agency

22 G) HDD: Hard Disk Drive

23 H) Hz: Hertz

24   I)   IEEE: Institute of Electrical and Electronics Engineers

25   J)   I/O: Input/Output

26   K)   k: Kilo

27   L)   NIST: National Institute of Science and Technology (USA)

28   M)   OS: Operating System

29   N)   PDU: Power Distribution Unit

30   O)   PSU: Power Supply Unit

31   P)   RMS: Root Mean Square

32   Q)   SSD: Solid State Drive

33   R)   UPS: Uninterrupted Power Supply

34   S)   UUT: Unit Under Test

35   T)   V: Volts

36   U)   W: Watts

5   TEST SETUP

38   A)   <u>Input Power</u>: Input power shall be as specified in Ambient Temperature: Ambient temperature shall
39   be no less than 18 °C and no greater than 28 °C over the duration of the test.

40   B)   <u>Relative Humidity</u>: Relative humidity shall be within 15% and 80%.

41   C)   Table 1 and Table 2. The frequency for input power shall be as specified in Table 3.

42   D)   <u>Ambient Temperature</u>: Ambient temperature shall be no less than 18 °C and no greater than 28 °C
43   over the duration of the test.

44   E)   <u>Relative Humidity</u>: Relative humidity shall be within 15% and 80%.

45 **Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or**
46 **Equal to 1500 W**

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with Ac-Dc Single-Output PSUs	230 V ac	+/- 1.0 %	2.0 %
Servers with Ac-Dc Multi-Output PSUs	230 V ac and/or 115 V ac		
Optional Testing Conditions For Ac-Dc Japanese Market	100 V ac		
Dc Servers	+/- 53 V dc	+/- 1.0 V	

47 **Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than**
48 **1500 W**

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with Ac-Dc Single-Output PSUs	230 V ac	+/- 4.0 %	5.0 %
Servers with Ac-Dc Multi-Output PSUs	230 V ac and/or 115 V ac		
Optional Testing Conditions For Ac-Dc Japanese Market	100 V ac		
Dc Servers	+/- 53 V dc	+/- 1.0 V	

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Note: For clarity purposes, voltage requirements are reorganized based on nameplate power ratings of the product. This is consistent with other ENERGY STAR Test Methods.

50 **Table 3: Input Frequency Requirements for All Products**

Supply Voltage	Frequency	Frequency Tolerance
100 V ac	50 Hz	
115 V ac	50 Hz	±1.0%
230 V ac	50 Hz or 60 Hz	

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52　F)　Power Meter: Power Meter(s) shall report true Root Mean Square (RMS) power and at least two of
53　　　the following measurement units: voltage, current and power factor. Power Meter(s) shall possess the
54　　　following attributes:

55　**Note**: The Power Meter language is revised to clarify required measurement outputs.

56　　　1)　Calibration: The meter shall be calibrated within the past one year of the test date, by a standard
57　　　　　traceable to National Institute of Science and Technology (USA) or a counterpart national
58　　　　　metrology institute in other countries.

59　**Note**: The Calibration provisions are added per Stakeholder recommendations for active mode testing.

60　　　2)　Crest Factor: An available current crest factor of 3 or more at its rated range value. For analyzers
61　　　　　that do not specify the current crest factor, the analyzer must be capable of measuring an
62　　　　　amperage spike of at least 3 times the maximum amperage measured during any 1 second
63　　　　　sample.

64　　　3)　Minimum Frequency Response: 3.0 kHz

65　　　4)　Minimum Resolution:

66　　　　　a)　0.01 W for measurement values less than 10 W;

67　　　　　b)　0.1 W for measurement values from 10 W to 100 W; and

68　　　　　c)　1.0 W for measurement values greater than 100 W.

69　　　5)　Logging: The reading rate supported by the meter shall be at least 1 set of measurements per
70　　　　　second, where set is defined as watts. The data averaging interval of the analyzer shall equal the
71　　　　　reading interval. Data averaging interval is defined as the time period over which all samples
72　　　　　captured by the high-speed sampling electronics of the analyzer are averaged to provide the
73　　　　　measurement set.

74　**Note**: The Logging provisions for power measurements are added per Stakeholder recommendations for
75　active mode testing.

76　　　6)　Measurement Accuracy: Measurement uncertainty as introduced by the instrument that measures
77　　　　　the input power to the product under test, including any external shunts.

78　　　　　a)　Power measurements with a value greater than or equal to 0.5 W shall be made with an
79　　　　　　　uncertainty of less than or equal to 2% at the 95% confidence level.

80　　　　　b)　Power measurements with a value less than 0.5 W shall be made with an uncertainty of less
81　　　　　　　than or equal to 0.01 W at the 95% confidence level.

82　G)　Temperature Sensor: The temperature sensor shall possess the following attributes:

83　　　1)　Logging: The sensor shall have a minimum reading rate of 4 samples per minute.

84　　　2)　Measurement Accuracy: Temperature must be measured no more than 50 mm in front of (upwind
85　　　　　of) the main airflow inlet of the UUT and reported by the sensor with an overall accuracy of ± 0.5
86　　　　　°C or better.

87　**Note**: The Temperature Sensor provisions are added per Stakeholder recommendations for active mode
88　testing.

6 TEST CONDUCT

6.1　Active Mode Efficiency Test Configuration

91　The Partner must test and report power and efficiency test results for the computer servers being
92　tested. Testing shall be conducted as follows:

93　A)　As-shipped Condition: Products shall be tested in their "as-shipped" configuration, which includes
94　　　both hardware configuration and system settings, unless otherwise specified in this test method.
95　　　Where relevant, all options and software shall be set to their default condition.

96　B)　Measurement Location: All power measurements shall be taken at a point between the ac or dc
97　　　power source and the unit under test (UUT). No Uninterruptible Power Supply (UPS) units may be
98　　　connected between the power meter and the UUT. The power meter shall remain in place until all Idle
99　　　and full load power data are fully recorded.

100　C)　Airflow: Overtly directing air flow in the vicinity of the measured equipment in a way that would be
101　　　inconsistent with normal data center practices is not allowed.

102　**Note**: The Airflow provision is added per Stakeholder recommendations for active mode testing.

103　D)　Power Supplies: All PSUs must be connected and operational.

104　　　1)　UUTs with Multiple PSUs: All power supplies must be connected to the ac or dc power source
105　　　　　and operational during the test. If necessary, a Power Distribution Unit (PDU) may be used to
106　　　　　connect multiple power supplies to a single source. If a PDU is used, any overhead electrical use
107　　　　　from the PDU shall be included in the power measurement of the UUT. When testing blade
108　　　　　servers with half-populated chassis configurations, the power supplies for the unpopulated power
109　　　　　domains can be disconnected.

110　E)　Power Management and Operating System: The as-shipped operating system or a representative
111　　　operating system must be installed. Products that are shipped without operating systems must be
112　　　tested with any compatible operating system installed. For all tests, manufacturers must ensure that
113　　　only the power management techniques and/or power saving features which are enabled on
114　　　shipment are those enabled on the UUT. Any power management features which require the
115　　　presence of an operating system (i.e. those that are not explicitly controlled by the BIOS or
116　　　management controller) must be tested using only those power management features enabled by the
117　　　operating system by default.

118　F)　Storage (HDD, SSD): Products shall be tested for qualification with at least one hard drive (HDD or
119　　　SSD) installed. Products that do not include pre-installed hard drives (HDD or SSD) must be tested
120　　　using a configuration that is identical in all respects with the exception of installation of at least one
121　　　installed hard drive available for sale with the product. Products that do not support installation of
122　　　hard drives (HDD or SDD) and instead rely exclusively on external storage solutions (e.g., storage
123　　　area network) shall be tested using external storage solutions.

124 | **Note**: Language is clarified regarding testing of Computer Servers shipping without an installed storage
125 | device. EPA welcomes feedback on appropriate conditions for Servers designed to rely exclusively on
126 | external storage.

127 G) Blade and Dual/Multi-Node Servers: A Blade or Dual/Multi-Node Server must have identical
128   configurations for each node or blade including all hardware components and software/power
129   management settings. These systems must also be measured in a way to ensure that all power
130   from all tested nodes/blades is being captured by the power meter during the entire test.

131 H) Blade Chassis: The blade chassis, at a minimum, shall have power, cooling and networking
132   capabilities for all the blade servers. The chassis shall be populated as specified in section 6.2 B). All
133   power measurements for blades shall be made at the input of the chassis.

134 I) BIOS and UUT System Settings: All BIOS settings shall remain as-shipped unless otherwise
135   specified in the test method.

136 J) I/O and Network Connection: The UUT must have at least one port connected to an Ethernet network
137   switch. The switch shall be capable of supporting the UUT's highest and lowest rated network
138   speeds. The network connection must be live during all tests, and although the link must be ready
139   and able to transmit packets, no specific traffic is required over the connection during testing. The
140   UUT shall be set up with minimal I/O add-in cards; for testing, ensure the server offers at least one
141   Ethernet port (using a single add-in card only if no onboard Ethernet support is offered).

142   1) Ethernet Connections: Products shipped with support for Energy Efficient Ethernet (compliant
143   with IEEE 802.3az) shall be connected only to Energy Efficient Ethernet compliant network
144   equipment during testing. Appropriate measures shall be taken to enable EEE features on both
145   ends of the network link during all tests.

6.2   UUT Preparation

147 Computer Server power and efficiency must be determined and reported under the following
148 conditions:

149 A) Record the UUT manufacturer, model name, and configuration details, including: operating system
150   name and version, processor type and speed, installed power supplies, physical memory, hard drive
151   configuration, installed I/O devices, power management features enabled, etc. Record nameplate
152   power ratings.

153   1) When testing a blade server, also record the blade chassis model.

154 B) Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is
155   complete. If the UUT is a blade system, populate the chassis as follows:

156   1) All blade servers installed in the chassis must be identical, sharing the same configuration
157   (homogeneous).

158   2) Chassis Population (Full)

159   a) Populate all available chassis bays. All power supplies and cooling fans shall be connected.
160   Proceed with all required tests in the test procedure.

161   3) Chassis Population (Half)

162   a) Populate half of the available chassis bays.

163　　　　　b) Follow all user manual recommendations for partially populating the chassis, which may
164　　　　　　　include disconnecting some of the power supplies and cooling fans for the unpopulated
165　　　　　　　power domains.

166　　　　　c) If user manual recommendations are not available or are incomplete, then use the
167　　　　　　　following guidance:

168　　　　　　　i. When loading blades, completely populate one power domain of the chassis at a
169　　　　　　　　time.

170　　　　　　　ii. For partially-populated power domains, place the blades from the center outward.

171　　　　　　　iii. Fill all empty bays with blanking panels or an equivalent airflow restriction for the
172　　　　　　　　duration of testing.

173 C) Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection must be
174　　maintained for the duration of testing, except for brief lapses necessary for transitioning between
175　　link speeds. If a controller system is required to provide workload harness control, data acquisition,
176　　or other UUT testing support, the controller system shall be connected to the same network switch
177　　as the UUT and satisfy all other UUT network requirements.

178 D) Connect the power analyzers to an ac or dc voltage source set to the appropriate voltage and
179　　frequency for the test as specified in Section 4 of this test method.

180 E) Plug the UUT into the measurement power outlet on the power analyzer, using the following
181　　guidelines:

182　　1) No UPS units shall be connected between the power analyzer and the UUT;

183　　2) The power analyzer shall remain connected until all testing is complete;

184　　3) When testing a blade system, power shall be measured at the input of the blade chassis (i.e. at
185　　　　the power supplies that convert data center distribution power to chassis distribution power);

186　　4) If a controller system is being used, connect the data output interface of the power analyzer(s)
187　　　　to the appropriate input of the controller system.

188 F) Verify that the UUT is configured in its as–shipped configuration.

189 G) Install manufacturer specified workload software on the UUT. Record the installed workload and
190　　configuration, including any custom parameters or settings.

191 H) Record the input voltage and frequency.

192　7　TEST PROCEDURE

193　7.1　Power and Efficiency Testing

194 A) Power on the UUT, either by switching it on or connecting it to mains power.

195 B) If necessary, power on the controller system.

196 C) Begin recording elapsed time.

197   D)   Between 5 and 15 minutes after the initial boot or log in, set the analyzer to begin accumulating
198   power values at an interval of greater than or equal to 1 reading per second.

199   1)   When testing using a controller system, the controller system may automate data accumulation
200   and benchmark workload operation provided the measurement interval requirements are met.

201   E)   Idle power measurement can be performed one of two ways:

202   1)   Automatic idle measurement: The workload automates the measurement of Idle power.

203   2)   Manual idle measurement: Accumulate Idle power values for 5 minutes before engaging the
204   workload. The UUT must maintain an Idle state throughout this period and must not enter lower
205   power states with limited availability (e.g., server sleep or hibernate states).

Note: DOE and EPA propose that for cases where the workload does not automate measurement of Idle power, manual Idle power measurements must be recorded before engaging any workload in order to avoid the aforementioned scenario. Such an approach is intended to avoid the system not fully entering an idle state due to remnants from active testing remaining present in the background. DOE and EPA welcome comments on this proposal.

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207   F)   Engage workload operation.

208   G)   Record the following data at the end of workload operation:

209   1)   Average Idle power (arithmetic mean) during the automated Idle state period; or

210   2)   Average Idle power (arithmetic mean) during the 5 minute test period.

211   H)   Record On Mode power averaged over the workload duration. If the workload is composed of
212   different worklets stressing different functionalities, then the average power for each worklet shall
213   be reported.

214   I)   When testing a Blade System, proceed as follows to derive single blade power:

215   1)   Divide the measured total power by the number of blades installed during the test;

216   2)   Record the per-blade power values for each measurement and the measured total power.

217   **8   REPORTING**

218   *Test Reporting Template for Computer Servers* shall be completed with the recorded data for each
219   Server tested.